







### 3. Methodology

The picked procedure for this article is the survey of the writing concentrating on ongoing articles (2013 – 2018) in light of the health care waste. This specific procedure is picked so as to have accessible effect of medicinal services waste in the Republic of South Africa. The publications were chosen dependent on the importance to the health care waste and its effect on patients. The examination question identified with this investigation were (1) What are the perilous effect of health care waste on patient and medicinal services providers? (2) What is the dimension of familiarity with health care suppliers on waste administration in South Africa?

Research publications were assessed and abridged to have an unmistakable view and further comprehension of the review of the health care squander management from the point of view of different analysts. A hole examination was led that comprised of issue explored, variable analyzed, approach pursued, discoveries, and setting of study just as region of future investigation of late articles distributed between 2013 – 2018 (Mukwakungu *et al.*, 2018).

The areas investigated while conducting the gap analysis, based on a study conducted by Mukwakungu *et al.* (2018) were respectively:

- **The problem** being investigated by the researcher(s) related to healthcare waste management in South Africa.
- **Variables examined:** identifying the factors that were taken into consideration when the research was conducted?
- **Methodology followed:** what methods did the researcher(s) used to conduct the research
- **Findings:** what have the researchers concluded in the topic in question
- **Context on study:** the focus of the study in this regard the context of the articles was in line with the practices and standards of healthcare management particularly in South Africa and the collection of data based on the topic at hand from various researchers.
- **Area of future study:** what area of future study did the researcher(s) identify a gap that other researchers should research about.

Following the above guidelines, a total of 16 articles were identified and guided this study. The gap analysis results are contained in detail in Table 2 found on Annexure A.

## 4. DISCUSSIONS

### 4.1. Knowledge of health care practitioners

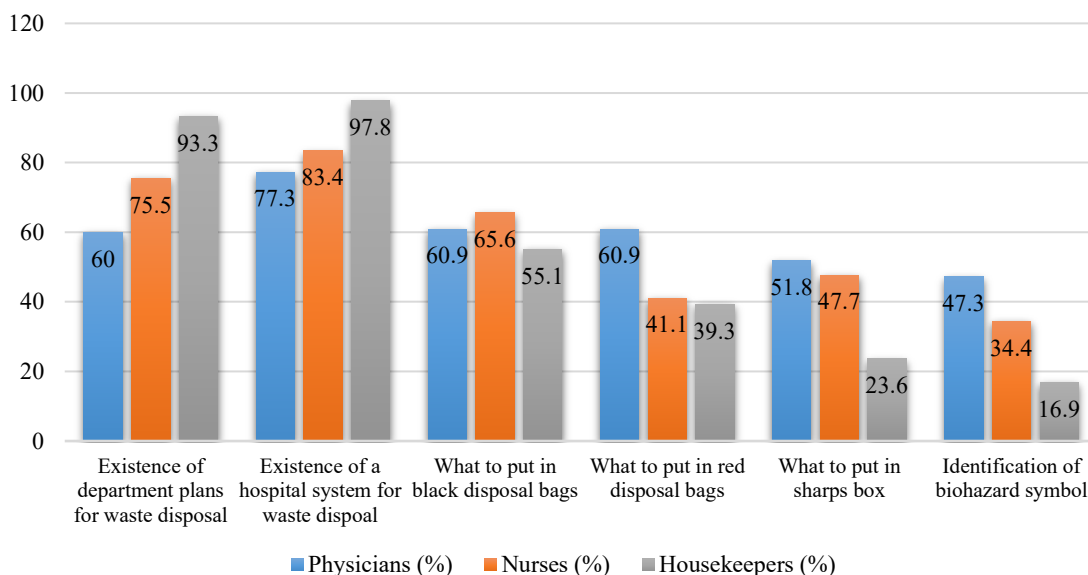


Figure 1. Knowledge of Healthcare Practitioners on Waste Disposal

In a study conducted by Hakim *et al.* (2014) on the knowledge and awareness of waste medical items, of housekeepers, nurses and physicians. The study found that physicians are more knowledgeable and aware of the biohazard symbols, as well as what to put in sharps boxes and what to put in red disposal bags in their work place, second are nurses and housekeepers are the least knowledgeable and aware. A high percentage of nurses are knowledgeable and aware of what to put in black disposal bags, followed by physicians and housekeepers are the least knowledge and aware of what to put in black disposal bags. A high percentage of t housekeepers have the knowledge and are aware of the existence of a hospital system for waste disposal and department plans for waste disposal, followed by nurses and physicians the least knowledge and aware of the existence of a hospital system for waste disposal and department plans for waste disposal. These findings are depicted in Figure 1 above.

#### 4.2 Attitude of health care practitioners

Hakim *et al.* (2014) conducted a study on the attitude healthcare practitioners have towards medical waste. The results, as depicted in Figure 2 below, show that a high percentage physicians have a positive attitude when it comes to safe disposal as the utmost important to prevent infection transmission, in cooperating with the hospital waste management team and in wearing PPE to decreases the risk of contracting infection at the hospital, followed by nurses and lastly housekeepers were found to have the least positive attitude when it comes to safe disposal as the utmost important to prevent infection transmission, in cooperating with the hospital waste management team and in wearing PPE to decreases the risk of contracting infection at the hospital. Furthermore, it was found that housekeepers have a high percentage of positive with regards to safe waste disposal should be a priority, Waste disposal is a team work not a hospital responsibility and Efforts in safe waste disposal are a financial burden on the administrative department of the hospital.

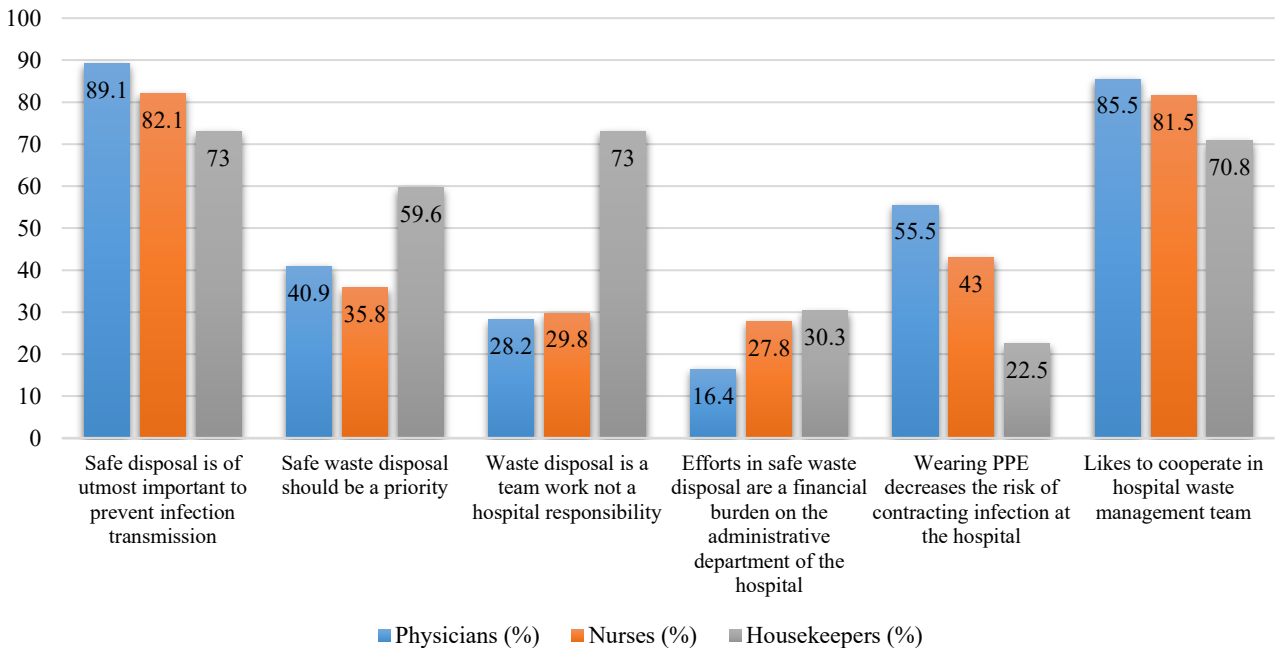


Figure 2. Attitude of Healthcare Givers

#### 4.3 Gap Analysis Results

The gap analysis results, as presented in Table 2, shows that authors mention that further research should be conducted and that a greater number of subjects should be included with regards to waste management policy and practices within the health care environment, as well as the need for more research and accurate data to provide an evidence-base for future decision-making is highlighted (Sharma *et al.* 2013). On the one hand, other authors recommend that research

must be undertaken to seal existing gaps in the knowledge about hospital waste management (Hakim, *et al.*, 2013). On the other hand, however, other researchers recommend that the management of hospitals organize training of all the new healthcare workers on HCW management and that there should be periodic refresher courses for existing staff (Azwuie, *et al.* 2015).

From a South African perspective, it is important to indicate that a study conducted over ten years ago provided comprehensive recommendations related to existing hospital waste practices and recommendations on how to handle them. Nemathaga *et al.* (2008) recommended that:

- environmental health education be provided for nurses on hospital waste management supported by strict monitoring to enforce compliance.
- considering the high temperatures the area the hospital where the study was conducted is exposed to, waste collection must occur regularly, and cleaning of the central storage room should be done properly and waste being stored there should be inspected accordingly to avoid leakages.
- The two incinerators used at the hospital be immediately stopped as they are source of environmental and health hazard.
- The hospital should stop burning waste at landfills because it is a dangerous source of health problems and environmental pollution.

The above recommendations require the commitment to hospital waste management by staff and its management team to be implemented without adding financial burden. If the above recommendations dating over ten years back are anything to go by, recent studies also indicate that research exploring the perspectives stakeholders and policy makers in health care waste management in community-based care could help shed more light on the issue of health care waste (Hangulu and Akintola, 2017). Also note that followings are necessary: (1) a similar study using a qualitative method to engage participants through interviews and focused group discussions; (2) a research targeting other population groups not targeted in this study within the hospital; (3) a and studies focusing on the actual cost of managing waste are needed (Ramokate, 2008).

## **5. Recommendations, Conclusion and the Way Forward**

Based on the information provided in this study it is recommended that the Department of Health should work hand in hand with hospitals as well as community clinics to provide adequate and continuous training to healthcare givers on how to handle medical waste health (Hangulu & Akintola, 2017). To improve the health of patients and healthcare givers, the Department of Health should provide sufficient personal protective equipment (PPE) and medical training for healthcare practitioners should include waste management as noted by Hakim *et al.* (2013) and again by Hangulu and Akintola (2017). The relationship between healthcare waste management training programs and the safety of patients and health care givers cannot be over emphasized as Kumar *et al.* (2015) indicated. Healthcare facilities must ensure that health practitioners show all necessary standard procedures in how to handle waste produced when helping patients (Holla *et al.*, 2015).

## **Acknowledgements**

We would like to demonstrate our appreciation to the Faculty of Engineering and the Built Environment Dean's Office of the University of Johannesburg, for its support in providing the funds that enabled this project. We would also like to thank the Department of Quality and Operations Management at the Faculty of Engineering and the Built Environment of the University of Johannesburg for providing the facilities that allowed this research to be completed.

## **References**

- Azuike, E., Adinma, E., Nwabueze, S., Azuike, E., Mbanuzuru, V., Epundu, U., Enwonwu, K., Chikezie, N Ajator, C., Onebunne, E., Obi, D., Healthcare waste management: what do the health workers in a Nigerian tertiary hospital know and practice, *Science Journal of Public Health*, vol. 3, no. 1, pp. 114-118, 2015
- Azuike, E.C., Nwabueze, A. and Epundu, U., Healthcare waste management: what do the health workers in a Nigerian tertiary hospital know and practice, vol. 3, no. 1, pp. 114-118, 2015
- Bhardwa, M. and Joshi, R, Awareness on biomedical waste management (BMW) among undergraduate medical students of Punjab, *European Journal of Pharmaceutical and medical research*, vol. 3, no. 4, pp. 263-265, 2016
- Chudasama, R., Rangoonwala, M., Sheth, A., Misra, S., Kadri, A. and Patel, U., Biomedical Waste Management: A study of knowledge, attitude and practice among health care personnel at tertiary care hospital in Rajkot, *Journal of Research in Medical and Dental Science*, vol. 1, no. 1, 2013

- Elnour, A., Moussa, M., El-Borgy, M., Fadelella, N., Mahmoud, A., Impacts of health education on knowledge and practice of hospital staff with regard to Healthcare waste management at White Nile State main hospitals, Sudan, *International Journal of Health Sciences*, vol. 9, no. 3, 2015
- Enwere, O. and Diwe, K., Knowledge, perception and practice of injection safety and healthcare waste management among teaching hospital staff in south east Nigeria: an intervention study, vol. 17, no. 218, 2014
- Ghasemi, M. and Yusuff, R., Advantages and Disadvantages of Healthcare Waste Treatment and Disposal Alternatives: Malaysian Scenario, *Pol. J. Environ. Stud*, vol. 25, no. 1, pp. 17-25, 2015
- Hakim, S., Mohsen, A. and Bakr, I., Knowledge, attitudes and practices of health-care personnel towards waste disposal management at Ain Shams University Hospitals, Cairo, *Eastern Mediterranean Health Journal*, vol. 20, no. 5, 2013
- Hangulu, L and Akintola, O., Health care waste management in community-based care: experiences of community health workers in low resource communities in South Africa, vol. 17, pp. 448, 2017
- Hollal, R., Darshan, B., Sorake, N., Unnikrishnan, B., Thapar, R., Mithra, P., Kumar, N., Kulkarni, V and Kumar, A., Knowledge and practices regarding biomedical waste management among healthcare professionals in tertiary care hospitals of Mangalore, India, vol. 2, no. 4, pp. 656-659, 2015
- Kumar, R., Somrongthong, T. and Shaikh, B., Effectiveness of intensive healthcare waste management training model among health professionals at teaching hospitals of Pakistan: a quasi-experimental study, *BMC Health Services Research*, vol. 15, no. 81, 2015
- Liu, H., You, J., Lu, C and Chen, Z., Evaluating health-care waste treatment technologies using a hybrid multi-criteria decision-making model, *Renewable and Sustainable Energy Reviews*, vol. 41, pp. 932–942, 2014
- Mukwakungu S.C, Mabasa, M.D., Mbohwa, C., Review of Standard, Practices and Future Prospects of Project Management in a South African Context, *Proceedings of the 2nd European Conference on Industrial Engineering and Operations Management, Paris, France, July 26-27, 2018*, 2018
- Nemathaga, F., Maringa S. and Chimuka, L., Hospital solid waste management practices in Limpopo Province, South Africa: A case study of two hospitals, *Waste Management*, vol. 28, pp. 1236–1245, 2008
- Ramokate, T., Knowledge and practices of doctors and nurses about management of health care waste at Johannesburg Hospital in the Gauteng Province, South Africa (Doctoral dissertation), 2008.
- Sanjeev, R., Kuruvilla, S., Subramaniam, R., Prashant, P., and Gopalakrishnan, M., Knowledge, attitude, and practices about biomedical waste management among dental healthcare personnel in dental colleges in Kothamangalam: a cross-sectional study, *Health Sciences*, vol. 1, no. 3, pp. 1-12, 2014
- Sharma, A., Sharma, V., Sharma, S. and Singh P., Awareness of Biomedical Waste Management Among Health Care Personnel in Jaipur, India, *OHDH*, vol. 12, no. 1, pp. 32-40, 2013
- Thakur, V and Ramesh, A., Healthcare waste management research: A structured analysis and review (2005–2014), *Waste Management & Research*, vol. 33, no. 10, 855–870, 2016

## **Biographies**

**Sambil C. Mukwakungu** is an award-winning academic who has been lecturing Operations Management to first year students, Food Production, and Quality Management at the University of Johannesburg since 2009. His passion for teaching and learning has allowed him to make a difference in at least one student's life every year. He is a young researcher who is still establishing himself in knowledge creation with keen interest in Service Operations Management, Lean Operations, Continuous Improvement, as well as business innovation and innovation in Higher Education. He was awarded Best Track Paper Award in the 2016 IEOM Conference in Rabat, Morocco, and with his team from the IEOM UJ Student Chapter, he is recipient of the 2018 IEOM Outstanding Student Chapter Gold Award for exceptional chapter activities and contributions to the field of industrial engineering and operations management.

**Matimba Davis Mabasa** is a BTech student in Management Services at the University of Johannesburg, has completed short learning programme in Basics in Project Management, Basics in Total Quality Management, Strategic Management and programme in Sales and Marketing with the University of South Africa. Whose future prospects is to further do Post- graduate diploma in Management Services, MBA and Master's in Project Management.

Annexure 1 – Gap Analysis Results

Author(s), Title and Year	Problem Investigated	Variable Examined	Methodology Followed	Context of Study	Area of Future Study
Sanjeev R, Suneesh Kuruvilla, Subramaniam R, Prashant PS, and Meera Gopalakrishnan, <i>Knowledge, attitude, and practices about biomedical waste management among dental healthcare personnel in dental colleges in Kothamangalam: a cross-sectional study</i> , 2014	The study was conducted to assess the knowledge, attitude and practice of biomedical waste management among dental health care personnel in Kothamangalam, Kerala	health care personnel	A cross-sectional questionnaire based survey containing 24 questions to assess the knowledge, attitude and practice on biomedical waste management. The samples were the teaching faculty members and students of 3 dental colleges in Kothamangalam, Kerala. Results were expressed as a number and percentage of respondents for each question and Chisquare test was performed for inferential statistical analysis.	biomedical waste management	This study indicates that there is an urgent need to train the dental personnel regarding the same. Occupational safety is a prime concern.
Alok Sharma, Varsha Sharma, Swati Sharma, and Prabhat Singh, <i>Awareness of Biomedical Waste Management Among Health Care Personnel in Jaipur, India</i> , 2013	The study aimed to determine the awareness regarding biomedical (BM) waste management policy and practices, attitude towards biomedical waste management, and awareness regarding needle-stick injury and its prevalence among different categories of health care providers among the workforce of the Jaipur Dental College	workforce of the Jaipur Dental College,	A cross-sectional study was conducted using a questionnaire with closed-ended questions. It was distributed to 144 dentists, nurses, laboratory technicians and Class IV employees (cleaners and maintenance personnel) at Jaipur Dental College. The questionnaire was used to assess their knowledge of biomedical medical waste disposal. The resulting answers were graded and the percentage of correct and incorrect answers for each question from all the participants was obtained.	Biomedical (BM) waste management policy and practices	The authors recommend that similar studies should be performed, and more subjects should be included. The need for more research and accurate data to provide an evidence-base for future decision-making is highlighted.
Lydia Hangulu and Olagoke Akintola, <i>Health care waste management in community-based care: experiences of community health workers in low resource communities in South Africa</i> , 2017	In South Africa, community health workers (CHWs) working in community-based care (CBC) programmes provide care to patients most of whom are living with HIV/AIDS and tuberculosis (TB). This study explored HCWM in CBC in Durban, South Africa from the perspectives CHWs.	health care waste management (HCWM)	We used three ethnographic approaches to collect data: focus group discussions, participant observations and informal discussions. Data was collected from 85 CHWs working in 29 communities in the Durban metropolis, South Africa.	community health workers (CHWs)	Research exploring the perspectives stakeholders and policy makers in HCWM in CBC could help shed more light on this issue



Author(s), Title and Year	Problem Investigated	Variable Examined	Methodology Followed	Context of Study	Area of Future Study
Maryam Khadem Ghasemi, and Rosnah Bt. Mohd. Yusuff, <i>Advantages and Disadvantages of Healthcare Waste Treatment and Disposal Alternatives: Malaysian Scenario</i> , 2015	This article summarizes a literature review into healthcare waste and presents basic information on characteristics of them generated in healthcare centers.	healthcare waste management practices	Comprehensive literature review	healthcare waste management	Other potential treatment technologies must be examined as alternatives to incineration in order to better manage medical waste in Malaysia
S.A. Hakim, A. Mohsen and I. Bakr, <i>Knowledge, attitudes and practices of health-care personnel towards waste disposal management at Ain Shams University Hospitals, Cairo</i> , 2013	Assessment of knowledge, attitudes and practices of health-care providers towards waste management at Ain Shams University Hospitals, Cairo, Egypt.	health-care providers	In this cross-sectional study 110 physicians, 151 nurses and 89 housekeepers were interviewed using a pre-designed questionnaire	knowledge, attitudes and practices of health-care providers	Research must be undertaken to seal existing gaps in the knowledge about hospital waste management
Azuike, E.C., Adinma, E.D., Nwabueze, S.A., Azuike, E.D., Mbanuzuru, V.A., Epundu, U.U., Enwonwu, K.G., Chikezie, N.I., Ajator, C.C., Onebunne, E.M. and Obi, D.C., <i>Healthcare waste management: what do the health workers in a Nigerian tertiary hospital know and practice</i> , 2015	This study was carried out to determine the knowledge and practice of healthcare waste management by the healthcare workers in Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.	Healthcare waste	This was a cross-sectional descriptive study. There hundred and thirty one healthcare workers who have been in the employment of Nnamdi Azikiwe University Teaching Hospital were recruited into the study by proportionate sampling technique. Data was collected using a semi structured self-administered questionnaire.	healthcare workers	No further studies mentioned.
Felicia Nemathaga, Sally Maringa and Luke Chimuka, <i>Hospital solid waste management practices in Limpopo Province, South Africa: A case study of two hospitals</i> , 2007	The shortcomings in the management practices of hospital solid waste in Limpopo Province of South Africa were studied by looking at two hospitals as case studies.	Health care management practices	Apart from field surveys, the generated hospital waste was weighed to compute the generation rates and was followed through various management practices to the final disposal	hospital solid waste	
Dr. Monika Bhardwaj and Dr. Rajiv Joshi, <i>Awareness on Biomedical Waste Management (BMW) Among Undergraduate Medical Students of Punjab</i> , 2016	The assessment of Biomedical waste (BMW) collection and its proper disposal.	Students of a medical college in Punjab	An observational descriptive study was done on 110 students of second professional year at a medical college in Punjab by administering a pre-designed questionnaire.	Biomedical waste, awareness,	Emphasis should be given to good quality training to the MBBS students at regular time interval.

<b>Author(s), Title and Year</b>	<b>Problem Investigated</b>	<b>Variable Examined</b>	<b>Methodology Followed</b>	<b>Context of Study</b>	<b>Area of Future Study</b>
Ramesh Holla, Bhagawan B. Darshan, Nidhika Sorake, Bhaskaran Unnikrishnan, Rekha Thapar, Prasanna Mithra, Nithin Kumar, Vaman Kulkarni and Avinash Kumar, <i>Knowledge and practices regarding biomedical waste management among healthcare professionals in tertiary care hospitals of Mangalore, India, 2015</i>	This study was conducted to determine the knowledge of health care professionals about the proper disposal of biomedical waste and practice in following preventive measures while handling bio medical waste.	knowledge of health care professionals	This cross sectional study was conducted at three tertiary care teaching hospitals attached to Kasturba Medical College (KMC), Mangalore. Health care professionals comprising of doctors, nurses, lab technicians and class IV employees were enrolled in the study based on convenient sampling technique after obtaining their informed written consent. The data was collected using a pre-tested, semi structured questionnaire. SPSS Version 16.0 was used for entering the data and analysis.	biomedical waste management	
amesh Kumar, Ratana Somrongthong and Babar Tasneem Shaikh, <i>Effectiveness of intensive healthcare waste management training model among health professionals at teaching hospitals of Pakistan: a quasi-experimental study, 2015</i>	Assessment of effectiveness of Intensive healthcare waste management (IHWM) training model at two tertiary care hospitals of Rawalpindi city, Pakistan.	Infectious waste management	This study was quasi-experimental pre and post design with control and intervention groups. Out of 275 health care workers enrolled for the study, 138 workers were assigned for intervention group for 3 months trainings, hands-on practicum and reminders on infectious waste management; whereas 137 workers were assigned to the control hospital where routine activities on infectious health care waste management were performed. Pre and post intervention assessment was done for knowledge, attitude and practices (KAP); and was statistically analyzed.	health care workers	
Rajesh K Chudasama, Matib Rangoonwala, Ankit Sheth, SKC Misra, A M Kadri and Umed V Patel, <i>Biomedical Waste Management: A study of knowledge, attitude and practice among health care personnel at tertiary care hospital in Rajkot, 2013</i>	Bio medical waste (BMW) collection and proper disposal has become a significant concern for both the medical and general community. Effective management of biomedical waste is not only a legal necessity but also a social responsibility.	the knowledge, attitude and practice among health care personnels working in tertiary care centre	The study was conducted from January 2013 to June 2013. It was a descriptive observational hospital based cross sectional study. Study participants included the resident doctors intern doctors, nursing staff, laboratory technicians, ward boys and sweepers working in the institute who are dealing with BMW. The study was conducted by using pretested, semi-structured proforma.	management of biomedical waste	

<b>Author(s), Title and Year</b>	<b>Problem Investigated</b>	<b>Variable Examined</b>	<b>Methodology Followed</b>	<b>Context of Study</b>	<b>Area of Future Study</b>
Oguamanam Okezie Enwere and Kevin Chiekulie Diwe, <i>Knowledge, perception and practice of injection safety and healthcare waste management among teaching hospital staff in south east Nigeria: an intervention study</i> , 2014	This study determined the baseline and post-intervention knowledge and practice of modern injection safety standards among health care workers who are exposed to the risk of blood-borne diseases such as HIV, Hepatitis B and C in their daily encounter with infected patients and materials through unsafe injections.		The study population was the healthcare workers in a teaching hospital in southeastern Nigeria. Data was collected using a self-administered 37-item structured questionnaire assessing their knowledge and practice on injection safety. Collected data was analyzed using SPSS.	Health care workers	
Tuduetso Ramokate, <i>Knowledge and Practices of Doctors and Nurses About Management of Health Care Waste at Johannesburg Hospital in the Gauteng Province, South Africa</i> , 2008	The main aim of this study was to evaluate the current knowledge and practices of doctors and nurses regarding the management of health care waste.		This was a descriptive cross-sectional study. A self-administered questionnaire was used to collect the data. A total sample of 128 doctors and nurses was drawn from the Johannesburg Hospital, an academic hospital in the Gauteng Province		The followings are necessary: (1) a similar study using a qualitative method to engage participants through interviews and focused group discussions; (2) a research targeting other population groups not targeted in this study within the hospital; (3) Actual cost of managing waste.
Vikas Thakur and A Ramesh, <i>Healthcare waste management research: A structured analysis and review (2005–2014)</i> , 2015	The importance of healthcare waste management in preserving the environment and protecting the public cannot be denied.	This article analyses this scattered knowledge in a systematic manner, considering the period between January 2005 and July 2014.	The authors conducted a systematic review of 176 articles on healthcare waste management taken from the following eight esteemed journals: International Journal of Environmental Health Research, International Journal of Healthcare Quality Assurance, Journal of Environmental Management, Journal of Hazardous Material, Journal of Material Cycles and Waste Management, Resources, Conservations and Recycling, Waste Management, and Waste Management & Research. The authors have applied both quantitative and qualitative approaches for analysis.	healthcare waste management	Overall, our study is both qualitative as well as quantitative, which provides an aggregate overview of the research agenda development from January 2005 to July 2014 in the area of HCWM, and thus identify the future research avenues.

<b>Author(s), Title and Year</b>	<b>Problem Investigated</b>	<b>Variable Examined</b>	<b>Methodology Followed</b>	<b>Context of Study</b>	<b>Area of Future Study</b>
Ahmed Mohammed Elnour, Mayada Mohamed Reda Moussa, Mohamed Darwish El-Borgy, Nur Eldin Eltahir Fadelella, Aleya Hanafy Mahmoud, <i>Impacts of health education on knowledge and practice of hospital staff with regard to Healthcare waste management at White Nile State main hospitals, Sudan, 2015</i>	The study aims at assessing nursing and sanitation staff knowledge and practice regarding Healthcare Waste (HCW) management before and after the implementation of an educational intervention program at the main hospitals of the White Nile State in Sudan.	Assessing nursing and sanitation staff knowledge and practice regarding Healthcare Waste (HCW) management	Quasi-experimental study design was applied to assess the impact of an intervention program on knowledge and practice regarding HCW management. The same questionnaire used in the pre-test was used immediately after the end of the intervention program and then again three months later for a second post-test.	Healthcare Waste (HCW) management	